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Studies on Lesion Nematodes and Corn Rootworms on Corn[1]

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ABSTRACT

Lesion nematodes (Pratylenchus hexincisus) inoculated in field microplots reproduced poorly in corn over a four year period. In the initial two years of the study, it appeared insufficient numbers of nematodes were added to the plots. However, in smaller microplots used in the final years of the study, lesion nematode reproduction was also poor. Cool, moist soil conditions in the last two years of the study may have hindered nematode reproduction. Corn rootworms (Diabrotica virgifera) survived well in the microplots, and in two of the four years significantly reduced corn yield.

In a three year vertical distribution study of lesion nematode populations in first year corn, the highest soil populations occurred in the 10-20 cm depth increment. Soil populations increased from the 0-10 to the 10-20 cm sampling depth and then declined with increasing sampling depth. Root populations of lesion nematodes were also highest in the 10-20 cm depth increment. Roots in the 0-10 cm soil layer supported fewer lesion nematodes per gram of root than did roots at the 10-20 cm sampling depth. The highest root and soil populations occurred in 1981 and the cool, moist 1982 season resulted in significantly lower lesion nematode populations.

In a greenhouse study, there were significant differences in reproduction of P. hexincisus in 34 North Central corn inbred lines. In greenhouse groundbed studies, inbreds SD24, SD18, SDp236m and SDp254 frequently supported very high populations of P. hexincisus. Inbreds SD15, SDp312, and SD29 appeared to be less susceptible to P. hexincisus.

INTRODUCTION

Plant parasitic nematodes are important factors in corn production in several North Central States (4, 5, 6, 7, 8, 9), and lesion nematodes (*Pratylenchus* spp.) are among the most important (11). In South Dakota, corn rootworms (*Diabrotica* spp.) are also important factors and often both lesion nematodes and rootworms occur in the same field, particularly in continuously cropped corn. Both chemical and cultural control procedures for lesion nematodes in corn are complicated by interactions with corn rootworms.

There is very little information concerning the vertical distribution of lesion nematodes in corn. Such information should prove useful in improving the placement of nematicides and also evaluating the effects of various tillage practices. Several studies have measured the reproduction of *Pratylenchus* spp. in corn inbreds (3, 10), and several inbreds have been identified that support significantly fewer lesion nematodes. However, only a very small number of inbreds have been tested and more studies are needed.

The objectives of the present study were to (1) investigate effects and interactions of *Pratylenchus hexincisus* and *Diabrotica virgifera* alone and in combination on growth of corn in field microplots, (2) determine population dynamics and vertical distribution of lesion nematodes in first year corn, and (3) evaluate corn inbred lines for sources of resistance to *P. hexincisus*.

MATERIALS AND METHODS

Microplot Studies

Field microplots, 0.5 m^2, were established at the USDA Research Farm near Madison, SD. Soil in the study area was a clay loam and mechanical texture was 35% sand, 27% silt, and 38% clay. A trenching tool was used to dig a narrow trench to a depth of 60 cm on the perimeter of each plot. A sleeve of 4 mil polyethylene was then slipped over the resulting soil block to isolate the

microplot. The microplots were fumigated in late October each year of the study with Telone-II (1 - 3 dichloropropene) at 120 ml/m^3. The 1980 microplot treatments consisted of several inoculum levels of P. hexincisus and D. virgifera alone and in combination in a factorial arrangement. Lesion nematode levels were 0, 3,000, and 16,000/plot and rootworm levels were 0, 900, and 1800 eggs/plot. Each of the nine treatments was replicated four times in a randomized complete block design. Lesion nematode inoculum was obtained from a greenhouse colony maintained in corn. Plots were inoculated and seeded with a corn hybrid (Pioneer 3901) in early June and several days after emergence plants were thinned to two per plot. Nematode populations were assessed at mid-season and at harvest and corn rootworm damage was measured at harvest.

In 1981, microplot experiments were divided into two studies. In the first study, inoculum levels of P. hexincisus were 0 and 30,000/plot and D. virgifera levels were 0 and 900 eggs/plot. Treatments were factorially arranged with three replications. Plots in the second study were inoculated with 0, 30,000, or 60,000 P. hexincisus/plot. Each treatment was replicated three times. Nematode inoculum consisted of chopped, lesion nematode infested corn roots obtained from a greenhouse colony in corn. Plots were inoculated and seeded in late May in a manner similar to that in 1980.

The 1982 microplots were reduced in size by forcing two 30 cm diameter plastic tubes to a depth of 60 cm in each of 22 of the original microplots. Two studies were conducted in the smaller microplots. Inoculum levels in the first study were 0 and 32,000 P. hexincisus/plot and 0 and 300 D. virgifera eggs/plot factorially arranged in a randomized complete block design with six replications. Plots in the second study were inoculated with 0, 16,000, 32,000, or 48,000 P. hexincisus/plot. Each treatment was replicated five times. Plots were inoculated and seeded with hybrid Pioneer 3732 in late May and plants were

thinned to one per plot several days after emergence. Nematode inoculum again consisted of chopped, lesion nematode infested corn roots obtained from a greenhouse colony maintained in corn.

Insufficient lesion nematode inoculum was available in 1983 and the size of the experiments was reduced. The first study consisted of three treatments, a non-inoculated control, 300 D. virgifera eggs and 300 D. virgifera eggs plus 20,000 P. hexincisus. Each treatment was replicated four times, and again nematode inoculum was contained in chopped roots. A second study measured effects of a stunt nematode, Tylenchorhynchus nudus. Inoculum levels were 0, 15,000, and 30,000 T. nudus/plot. Nematode inoculum was obtained from a greenhouse colony maintained on winter wheat. Treatments were replicated four times. Plots were inoculated and seeded with corn hybrid O's Gold 949 in late May and thinned to one plant per plot several days after emergence.

Population dynamics and vertical distribution studies

Soil cores, 5 cm diameter, were removed to a depth of 60 cm in June, July, August, September, and October from first year corn at the Madison farm in 1980, 1981, and 1982. Cores were removed within 10 cm of the base of a plant. Three cores were removed at each randomly selected location and subdivided into 0-10, 10-20, 20-30, 30-40, 40-50, and 50-60 cm increments. The three cores were combined by increment and each location was replicated three times. Each soil sample was thoroughly mixed, root pieces removed, and nematodes extracted from a 100 cc subsample by the method of Christie and Perry (2). In August, September, and October, endoparasites were extracted from washed, chopped roots by the method of Bird (1). Nematode densities were determined by counting the number present in three 1-ml aliquants of a 50 ml suspension.

Reproduction in corn inbreds

The initial greenhouse study measured reproduction of P. hexincisus in 34

corn inbreds from various North Central states. Inbreds were planted in 18 cm diameter clay plots containing 1200 cc of soil infested with 500 P. hexincisus per pot. Each treatment was replicated four times and pots were randomly arranged on a greenhouse bench. Four months after planting, tops were clipped at soil level and pots were replanted. Four months later tops were again clipped, root balls removed, and roots were carefully washed, chopped, thoroughly mixed, and nematodes were extracted from a 2 g subsample of each. Greenhouse air temperature was maintained at 25 ± 2 C and supplemental lighting was supplied to provide a 16 hr day. Pots were fertilized monthly with a 20-20-20 NPK fertilizer.

Three subsequent experiments were conducted in a greenhouse groundbed artificially infested with P. hexincisus. The majority of inbreds tested in these studies were products of several South Dakota corn breeding projects. Inbreds were planted in a randomized complete block design with four replications. Three to four months after planting, plants were dug, roots washed, chopped, and nematodes were extracted from a 2 g subsample.

RESULTS AND DISCUSSION

Microplot Studies

In the initial microplot study (Table 1) only D. virgifera significantly reduced corn yield. Yield reductions for the low and high infestation levels were 19 and 32%, respectively. Lesion nematode survival and reproduction was very poor. In an attempt to improve lesion nematode survival, plots in the second study (Table 2) were inoculated with P. hexincisus infested chopped roots. However, survival of lesion nematodes was again poor. In addition, results were confounded by the presence of lesion nematodes in the control plots, apparently a result of inadequate fumigation the prior fall. Corn rootworms survived well, however, none of the treatments significantly reduced corn

yield.

The 1982 microplots were reduced in size to obtain a higher initial density of lesion nematodes. Survival of lesion nematodes was again very poor in both 1982 studies (Table 3). Soil temperatures were 2 to 3 C cooler in the microplots than in surrounding soil for most of the growing season, which may have reduced lesion nematode reproduction. Also, the 1982 growing season was cool and moist in the Madison area which may have further limited lesion nematode reproduction. Corn rootworms survived well and substantially damaged corn roots, although none of the treatments significantly reduced corn yield.

Limited lesion nematode inoculum was available in 1983 and consequently treatments were reduced (Table 4). Lesion nematode survival and reproduction was poor, however, corn rootworms survived well and significantly reduced corn yield. Limited reproduction of T. nudus, an ectoparasite, was evident although corn yields were not reduced by this nematode (Table 4).

Because of the consistently poor survival and reproduction of P. hexincisus over all four years of the microplot studies, it is not possible to reach a conclusion regarding possible interactions of lesion nematodes and corn rootworms. Corn rootworms survived well in these studies and in two of the four years significantly reduced corn yields. Precise reasons for poor lesion nematode survival and reproduction have been difficult to determine. In 1980 and 1981, it appeared that insufficient inoculum was added to the microplots. Lesion nematode reproduction was also poor in the smaller microplots in 1982 and 1983, however, the cool, moist 1982 season generally limited lesion nematode reproduction in eastern South Dakota. It was also noted in 1982 and 1983 that soil moisture was higher in the microplots than in surrounding soil which indicates drainage in these smaller plots was impeded. This limited drainage may also have adversely affected lesion nematode survival and reproduction. In

addition, the rim of the microplots extended 10-15 cm above the soil surface, which would result in some shading and thus may have slowed warming of the soil which also would slow lesion nematode reproduction.

Table 1. Effect of *Pratylenchus hexincisus* and *Diabrotica virgifera* alone and in combination on growth of corn in microplots. 1980.

Treatment[a]	Yield g/plot	No. of *P. hexincisus*/ 100 cc soil August	No. of *P. hexincisus*/ 100 cc soil Harvest	Corn rootworm rating[b]
0 *P. hex*; 0 *D. vir.*	284[c]	0	0	1.0
Low *P. hex.*; 0 *D. vir.*	218	84	104	1.1
High *P. hex.*; 0 *D. vir.*	280	115	101	1.4
0 *P. hex.*; Low *D. vir.*[d]	173	0	0	3.8
Low *P. hex.*; Low *D. vir.*	202	50	175	3.4
High *P. hex.*; Low *D. vir.*	263	55	100	1.7
0 *P. hex.*; High *D. vir.*[d]	159	0	0	4.2
Low *P. hex.*; High *D. vir.*	192	44	210	4.5
High *P. hex.*; High *D. vir.*	183	240	105	4.1

[a] Low *P. hex.* = 8,000/plot, High *P. hex.* = 16,000/plot.
Low *D. vir.* = 900 eggs/plot, High *D. vir.* = 1,800 eggs/plot.

[b] Scale of 1-6, 1 = no feeding, 2 = minor feeding, 3 = severe root pruning, 4 = 1 node destroyed, 5 = 2 nodes destroyed, 6 = 3 or more nodes destroyed.

[c] Average of four replications.

[d] Yield reductions for low *D. virgifera* and High *D. virgifera* were 19 and 32%, respectively.

Table 2. Effect of *Pratylenchus hexincisus* and *Diabrotica virgifera* on growth of corn in microplots. 1981.

Exp.	Treatment	Yield	No. of P. hexincisus				Corn rootworm rating
			August		Harvest		
			100 cc soil	g root dry wt.	100 cc soil	g root dry wt.	
		g/plot					
I	Check	319[a]	0	21	32	266	1
	30,000 *P. hex.*	304	4	32	343	1316	1
	D. vir.[b]	349	0	64	113	1280	4.0
	30,000 *P. hex.* + *D. vir.*	263	2	42	165	693	4.7
II	Check	423[c]	0	0	89	189	
	30,000 *P. hex.*	419	16	34	230	510	
	60,000 *P. hex.*	388	30	62	327	350	

[a] Average of three replications.

[b] 900 *D. virgifera* eggs added per plot.

[c] Average of four replications.

Table 3. Effect of Pratylenchus hexincisus and Diabrotica virgifera on growth of corn in microplots. 1982.

Exp.	Treatment	Yield g/plot	No. of P. hexincisus August 100 cc soil	Harvest 100 cc soil	Harvest g root dry wt.	Corn rootworm rating
I	Check	77.1[a]	0	0	0	1
	32,000 P. hex.	86.4	56	159	132	1
	D. vir.[b]	87.0	0	0	0	3.7
	32,000 P. hex. + D. vir.	68.3	25	83	1011	4.1
II	Check	70.2[c]	0	0	0	
	16,000 P. hex.	79.7	16	54	23	
	32,000 P. hex.	88.0	33	70	55	
	48,000 P. hex.	58.1	20	43	70	

[a] Average of six replications.

[b] 300 D. virgifera eggs added per plot.

[c] Average of five replications.

Table 4. Effect of *Pratylenchus hexincisus*, *Diabrotica virgifera*, and *Tylenchorhynchus nudus* on growth of corn in microplots. 1983.

Exp.	Treatment	Yield g/plot	No. P. hexincisus Harvest 100 cc soil	No. P. hexincisus Harvest g root dry wt.	Corn rootworm rating
I	Check	44.0[a]	0	0	1
	D. vir.[b]	9.1*	0	0	4.7
	20,000 *P. hex.* + *D. vir.*	11.1*	100	621	4.6

			No. of T. nudus/100 cc soil Harvest
II	Check	32.2	0
	15,000 *T. nudus*	25.7	313
	30,000 *T. nudus*	48.4	812

[a] Average of four replications.

[b] 300 *D. virgifera* eggs added per plot.

* Indicates significant reduction at .05 level.

Population dynamics and vertical distribution studies

Approximately 400 permanent mounts containing 2 to 10 specimens per slide were prepared of nematodes extracted from soil and roots, and the only species of Pratylenchus present was P. hexincisus (Appendix Table A1). The analysis of variance of P. hexincisus numbers in the soil revealed a significant ($P < 0.05$) second order interaction involving year, month, and sampling date. Consequently a Flsd was used to compare treatment means. Populations were significantly higher in the 10-20 cm sampling depth in several months in both 1980 and 1981 (Table 5), however, there were no significant differences in 1982. Populations tended to increase as the growing season progressed and the highest population occurred in October of 1981. In general, soil populations increased from the 0-10 to the 10-20 cm sampling depth and then declined with increasing sampling depth (Table 5).

In the analysis of variance of P. hexincisus numbers in roots, only the main effects year and sampling depth were significant ($P < 0.05$). Populations of P. hexincisus were significantly higher in 1981 and the lowest population occurred in 1982 (Table 6). Both the 1980 and 1981 growing seasons were above normal in growing degree days, however, the 1982 season was 366 growing degree days below normal. It appears the cooler 1982 season resulted in reduced lesion nematode reproduction.

Lesion nematode numbers in roots were significantly higher in the 10-20 cm depth increment than in all other increments except the 30-40 cm (Table 6). P. hexincisus numbers increased from 0-10 to 10-20 cm sampling depth, declined in the 20-30, increased in the 30-40, and then declined over the remaining sampling depths. Nematode populations in roots did not correspond to the consistent decline in the quantity of corn roots with increasing sampling depth. Also, it appears roots in the 0-10 cm soil layer are less suitable for lesion nematode

reproduction since they supported significantly fewer nematodes per gram of root than did roots in the 10-20 cm increment (Table 6). Lesion nematode populations per gram of root were also high in the 30-40 cm depth increment. The 30-40 cm layer is immediately below the plow layer and apparently conditions in this undisturbed soil as well as the smaller roots present results in a more favorable environment for lesion nematode invasion and reproduction. However, since relatively few roots are present in this layer, the populations in the 10-20 cm layer are probably of more importance. In addition, the higher populations of P. hexincisus in the 10-20 cm depth indicates that deeper incorporation or deeper placement of nematicides may improve lesion nematode control.

Table 5. Populations of Pratylenchus hexincisus in first year corn at six sampling depths.

Sampling Depth (cm)	Sampling Date														
	1980					1981					1982				
	June	July	Aug	Sept	Oct	June	July	Aug	Sept	Oct	June	July	Aug	Sept	Oct
0-10	23[a]	31	24	39	44	16	178	116	113	45	28	5	5	0	5
10-20	31	58	208	169	126	125	136	194	305	794	11	27	0	0	44
20-30	13	13	89	72	66	64	58	64	83	412	17	11	0	11	45
30-40	2	5	122	19	58	14	36	31	31	97	5	33	0	0	22
40-50	2	2	61	22	64	6	2	2	39	41	0	22	0	0	17
50-60	5	5	33	17	50	0	0	0	2	52	0	21	5	0	5

$Flsd_{.05}$ = 115

[a] Number in 100 cc soil - average of 3 replications.

Table 6. Populations of *Pratylenchus hexincisus* in roots over three years and vertical distribution of *P. hexincisus* and roots in first year corn.

Year	No. of P. hexincisus/g root (dry wt.)
1980	701[a]
1981	2001
1982	217
	$Flsd_{.05}$ = 770

Sampling Depth (cm)	No. of P. hexincisus/g root (dry wt)	Root Wt. (g)
0-10	722[b]	1.48[c]
10-20	2365	1.09
20-30	683	0.40
30-40	1295	0.24
40-50	489	0.18
50-60	283	0.13
	$Flsd_{.05}$ = 1640	

[a] Average of 54 observations (Aug., Sept., and Oct. sampling at six depths).

[b] Average of 27 observations (Aug., Sept., and Oct. sampling in 1980, 1981, and 1982).

[c] Fresh weight of roots removed from three 5 cm diameter soil cores to indicated depth. Average of three replications.

Reproduction in corn inbreds

There were significant differences in reproduction of P. hexincisus in thrity-four North Central corn inbreds in a greenhouse pot experiment (Table 7). The inbreds from Michigan tended to support fewer P. hexincisus than did several of those obtained from Iowa and Wisconsin. It would be worthwhile to evaluate several of the less susceptible inbreds more extensively in both greenhouse and field studies.

A series of studies was conducted to measure reproduction of P. hexincisus in corn inbreds grown in a greenhouse groundbed (Tables 8, 9, 10). Most of the inbreds tested were developed in South Dakota and one of the entries, SD24, appears to be very susceptible to P. hexincisus. Certain of the other inbreds responded in a less consistent pattern, however, SD18, SDp236m and SDp254 supported high populations of P. hexincisus in two of the three studies. Inbreds SD15 and SDp312 consistently supported fewer P. hexincisus than most of the other entries. Also, SD29 appeared to be less susceptible to P. hexincisus. Inbred Mo17 was considered very susceptible to Pratylenchus spp. in earlier studies (3, 10), however, in the present study it was intermediate in susceptibility.

The inconsistent response of certain of the inbreds in these studies (Tables 8, 9, 10) indicates care should be exercised in interpreting the results. While it is probable that a greenhouse groundbed more closely duplicates field conditions than greenhouse pots, it would be advisable to test several of these inbreds more extensively under field conditions.

Table 7. Reproduction of Pratylenchus hexincisus in selected North Central corn inbreds in the greenhouse.

Inbred	No. of P. hexincisus	Inbred	No. of P. hexincisus
Pa 73-18	1204[a]	CH 741-6	2896
Mich. 79-3	1239	ND 78-5	3100
CH 731-10	1304	CH 753-4	3639
CH 741-17	1321	CH 701-30	3713
Mich. 79-1	1543	Pa 76-1	3783
Mich. 79-4	1670	W 52	4022
ND 78-9	1683	A 77-3	4148
ND 77-3	1713	Pa 73-13	4908
A 77-5	1917	Pa 73-17	5074
Pa 76-2	2122	W 454	5435
Ia 78-1384	2139	A 77-6	5743
W 548	2196	Ia 78:1272	6317
A 77-8	2213	W 51	6539
A 77-7	2487	Pa 76-7	7322
Mich. 79-2	2522	Ia 78:1308	8130
Pa 73-11	2539	ND 77-1	8626
CH 705-8	2878	W 452	11643

$Flsd_{.05}$ = 1403

[a] Number in 1 g roots - dry wt. Average of 4 replications.

Table 8. Reproduction of Pratylenchus hexincisus in eleven South Dakota corn inbreds in a greenhouse groundbed.

Inbred	No. of P. hexincisus/g root (dry wt)
SD18	6853[a]
SDp236m	6711
SD24	6457
SDp254	5315
SD25	3800
SD10	3426
SDp311	3123
SDp312	2223
SD15	2196
SD29	1923
SDp310	1215

$Flsd_{.05}$ = 2580

[a] Average of 4 replications.

Table 9. Reproduction of Pratylenchus hexincisus in nine corn inbreds.

Inbred	No. of P. hexincisus/g root (dry wt)
SD24	5415[a]
SD18	5350
SDp310	3619
N28	3523
SD29	2450
Mo17	1619
SDp312	1438
SDp254	1157
SDp236m	1153
	$Flsd_{.05}$ = 2484

[a] Average of 4 replications.

Table 10. Reproduction of Pratylenchus hexincisus in fourteen corn inbreds in a greenhouse groundbed.

Inbred	No. of P. hexincisus/g root (dry wt)
SD9	6423[a]
SDp254	4934
SDp236m	4153
SD24	2946
Mo17	2580
SD29	2034
A619(a)	1557
A632	1476
SD22	1411
SD18	1346
A619(b)	1188
SDp312	1119
B73	784
SD15	734
	$Flsd_{.05}$ = 2311

[a] Average of 4 replications.

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Table A1. Nematode genera or species encountered among randomly selected individuals at six sampling depths in first year corn, July, September, and October samples, 1980 and 1981.

Depth: 0-10 cm	Depth: 10-20 cm
Acrobeles ctenocephalus	Acrobeloides minor
Acrobeloides minor	Aphelenchoides sp.
Aphelenchoides clarus	Aporcelaimellus krygeri
Aphelenchus avenae	Aporcelaimellus obscurus
Aporcelaimellus krygeri	Boleodorus similis
Aporcelaimellus obscurus	Boleodorus thylactus
Boleodorus thylactus	Cephalobus sp.
Cephalobus sp.	Diphtherophora sp.
Chiloplacus propinquus	Discolaimium sp.
Ditylenchus clarus	Ditylenchus sp.
Dorylaimellus occidentalis	Dorylaimellus occidentalis
Dorylaimoides teres	Dorylaimellus sp.
Ecumenicus monohystera	Eucephalobus oxyuroides
Eucephalobus oxyuroides	Eudorylaimus aquilonarius
Eudorylaimus modestus	Eudorylaimus miser
Eudorylaimus retractus	Eudorylaimus dubius
Labronema mauritiense	Eudorylaimus sp.
Lordellonema sp.	Helicotylenchus sp.
Nygolaimus sp.	Hoplolaimus galeatus
Paratylenchus projectus	Mesorhabditis sp.
Paratylenchus vexans	Nygolaimus paratenius
Plectus sp.	Paratylenchus vexans
Pratylenchus hexincisus	Pratylenchus hexincisus
Quinisulcius acutus	Quinisulcius acutus
Rhabditis sp.	Rhabditis sp.
Tylenchus exiguus	Tylenchus exiguus
Tylenchus parvissimus	Tylenchus parvissimus
Xiphinema americanum	Tylenchus plattensis
	Xiphinema americanum

[illegible]	0-10 cm
[illegible] leptorhynchus	
[illegible] minor	
[illegible] ciliatus	
[illegible] sylvaticus	
[illegible] [illegible]	
[illegible] [illegible]	
[illegible] [illegible]

Table A1. (Continued)

Depth: 20-30 cm	Depth: 30-40 cm
Acrobeloides minor	Acrobeloides minor
Aphelenchus avenae	Aporcelaimellus krygeri
Aporcelaimellus krygeri	Aporcelaimellus obscurus
Aporcelaimellus obscurus	Aporcelaimellus sublabiatus
Boleodorus thylactus	Cephalobus persegnis
Chiloplacus contractus	Diphtherophora sp.
Cephalobus persegnis	Dorylaimoides teres
Cervidellus serricephalus	Eudorylaimus dubius
Dorylaimellus occidentalis	Eudorylaimus miser
Dorylaimoides sp.	Eudorylaimus modestus
Eucephalobus sp.	Nygolaimus parabrachyurus
Eudorylaimus sp.	Paratylenchus vexans
Mononchus papillatus	Pratylenchus hexincisus
Nygolaimus paratenuis	Psilenchus sp.
Paratylenchus vexans	Quinisulcius acutus
Pratylenchus hexincisus	Tylenchus exiguus
Quinisulcius acutus	Tylenchus parvissimus
Rhabditis sp.	Xiphinema americanum
Tylenchus exiguus	
Xiphinema americanum	

Table A1. (Continued)

Depth: 40-50 cm	Depth: 50-60 cm
Acrobeloides minor	Acrobeles elaboratus
Aphelenchoides clarus	Acrobeloides minor
Aphelenchoides obtusus	Aphelenchoides sp.
Aphelenchus avenae	Aphelenchus avenae
Aporcelaimellus capitatus	Aporcelaimellus obscurus
Aporcelaimellus obscurus	Aporcelaimellus sublabiatus
Aporcelaimellus placus	Boleodorus similis
Aporcelaimellus sublabiatus	Boleodorus thylactus
Axonchium solitare	Cephalobus persegnis
Boleodorus acutus	Chiloplacus sp.
Cephalobus sp.	Dorylaimoides elegans
Chiloplacus sp.	Dorylaimoides teres
Diphtherophora obesum	Eucephalobus oxyuroides
Discolaimium conura	Eudorylaimus dubius
Ditylenchus microdens	Eudorylaimus miser
Dorylaimellus sp.	Paratylenchus vexans
Dorylaimoides elegans	Pratylenchus hexincisus
Dorylaimoides teres	Quinisulcius acutus
Labronema sp.	Tylenchus exiguus
Leptonchus fimbriatus	Xiphinema americanum
Nygolaimus paratenuis	
Paratylenchus projectus	
Pratylenchus hexincisus	
Quinisulcius acutus	
Tylencholaimus sp.	
Tylenchus exiguus	
Tylenchus parvissimus	
Xiphinema americanum	